Wind power stations

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The article describes the subject of renewable energy produced in Poland against the background of European Union. Special attention was devoted to utilization of the energy of the wind, representing a range of the types of wind turbines used in the construction of wind power stations. While presenting individual types both defects and the advantages of solutions were listed with the reference to the production of electric energy.

1. Introduction

The EU directive orders the limitation of emission of carbon dioxide by 20% and the increase of the production of renewable energy by 20% in the countries of European Union by 2020. For Poland this means 15% of renewable sources in the production of energy. Considering the preparations of Poland, it is easy to notice that the largest growth falls on use of the energy of the wind and the co-burning of biomass (Fig. 1) [1].

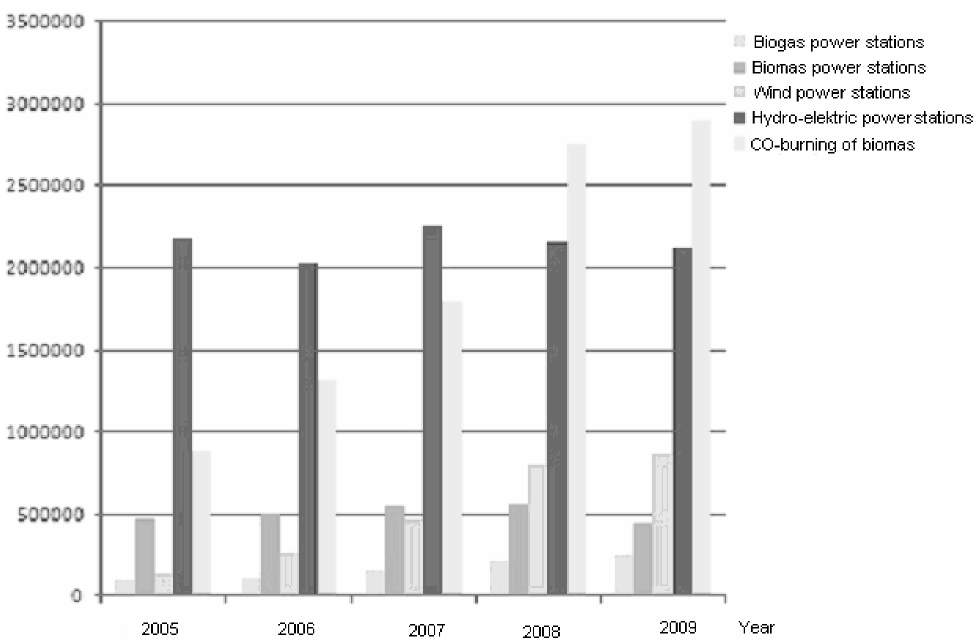

Fig. 1. The production of renewable energy in Poland [1]

In 2008, the total share of renewable energy was 4,27% [2], 0,51% of which [1] was from wind power stations. The comparison of power of installed wind power stations in Poland relative to the member countries of UE in 2007 is presented by Fig. 2. It is worth adding that in 2009 the power installed was 666 MW worth, while in 2010 it amounted to 1005 MW [1]. This corresponds to the aims imposed on Poland in the endeavor of realizing guidelines contained in the EU directive.

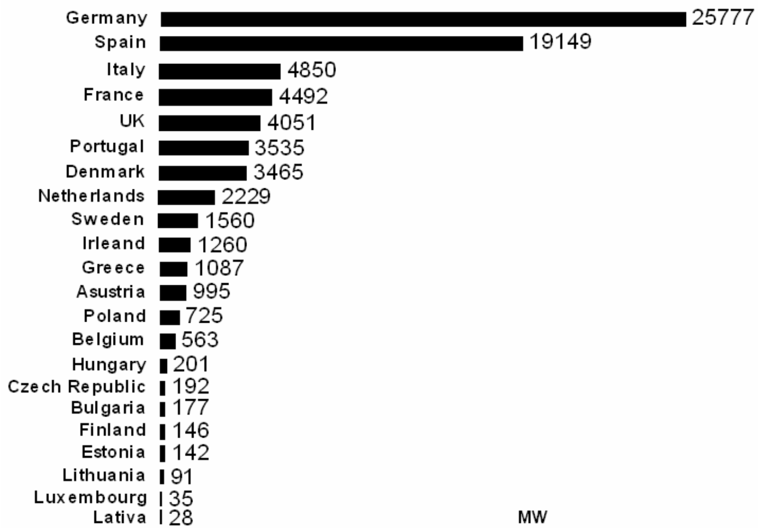

Fig. 2. The power installed of wind power stations in 2007 in UE on the basis of the data from EWEA [5]

2. The typed of wind power stations

Due to their construction, one can distinguish two types of wind power stations: those working in the horizontal axis, where the plane described through propellers is perpendicular to the direction of the strength of the influence of the wind, and those working in the perpendicular axis, working propellers of which create the cylinder, and the strength of the influence of the wind is directed to its side surface.

The wind power stations of the horizontal axis, appearing most frequently are three blade propellers (Fig. 3), making up the compromise between the large rotatory speed one and two blade propeller (Fig. 4), and the large rotatory moment low-speed multi blade propeller. They are characterized by the largest efficiency of processing the energy of the wind into electric energy.

The common features of the wind power stations of the horizontal axis:

- the necessity of placing them against the wind, realized through turning of the head, mostly by using the electric engines,
- the large durability of the tower which has to hold out the mass of wind turbine, transmission gear, and generator, and transfer the resistance force of all wind power station during the work near with the strong wind,

– the spades of the propeller with changing profile in relation to length with keeping the great precision of the realization and balancing of the whole propeller [4].

Fig. 3. Three blade propeller wind power stations of the horizontal axis installed on the bank of the backwater Jeziorsko, province łódzkie

Fig. 4. Wind power stations one and two blade propeller [9, 10]

Another way of usage of the wind turbine of the horizontal axis are the wind power stations with Magnus rotors, where the whirling cylinder was applied instead of the propeller. This solution allows to obtain considerably larger rotary moments of the propeller connected with considerably larger aerodynamic strength appearing on whirling rotors in comparison to traditional propellers. Unfortunately, electric engines were used to drive rolls, which, as a result, complicates constructions considerably and reduces the total efficiency of wind power station.

An example of such a wind power station together with the patern of the formation of aerodynamic strength, was presented below (Fig. 5).

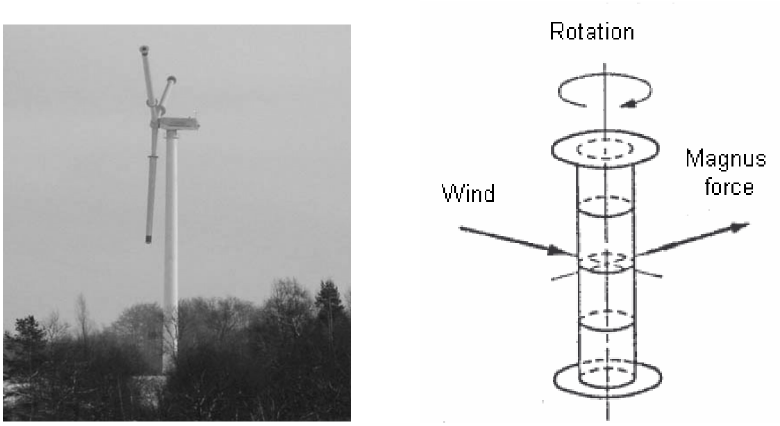

Fig. 5. Wind power station of horizontal axis with Magnus rotors, Acowind And-63 [6]

There are also types of wind power stations which are made with the rotors of Magnus which use other smaller wind turbines to drive rotors. These solutions did not bring positive effects, because the resistances of the rotation of the whole propeller grew. The Japanese firm Mecaro solved this problem, by applying a borer surface for the rotor together with with system of suitable transmissions on the main shaft of the wind power station (Fig. 6).

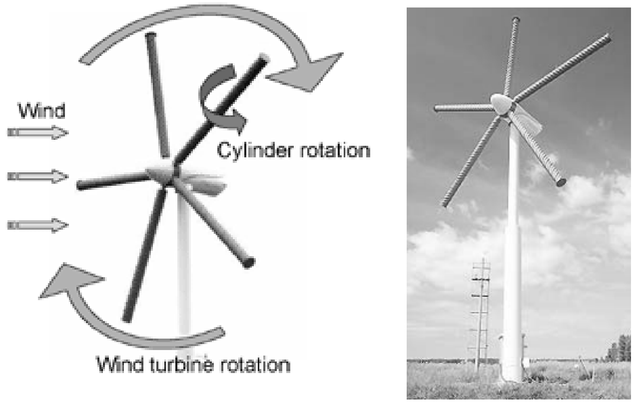

Fig. 6. Wind power station with Magnus rotors of the firm Mecaro [7]

Rotors begin to turn over simultaneously, producing buoyancy and the rotatory movement of the whole propeller as a result of the pressure of the wind. It is worth adding that the especially designed borer surface also causes enlargement of the circuit rotors which is directly connected with the larger circumferential speed and larger buoyancy produced.

The wind power stations of the perpendicular axis are divide into two groups differing in the way of the influence of the wind on the propeller wind turbine. Savonius rotor (Fig. 8) uses the front pressure of the wind.

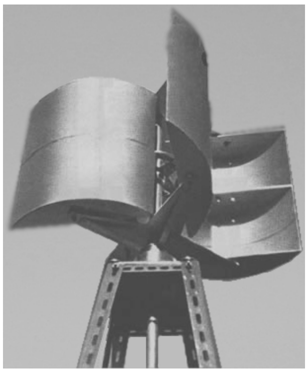

Fig. 8. The Savonius wind turbine [11]

The rotary speed, approximately the speed of the wind, and low efficiency was the reason why it was not used in the production of electric energy. However, it is frequently used for the wind speed measurement because of its rotary speed.

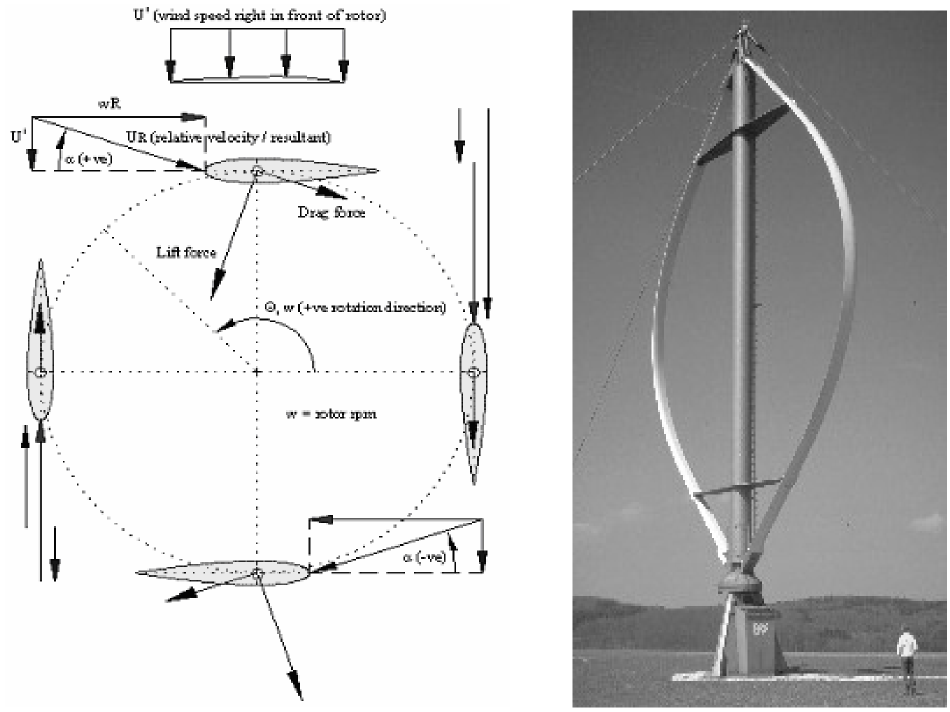

Fig. 9. The Darrieus wind turbine [11, 12]

Darrieus - rotor (Fig. 9) uses the side pressure of the wind thanks to which the buoyancy coming into being on its propellers allows to achieve larger rotary speeds. Low start-up torque is its characteristic feature as well as the necessity of using of the starter. The development of this type of wind turbine is H-Darrieus (Fig. 10), simplified construction which does not exact crooked spades of the propeller [3].

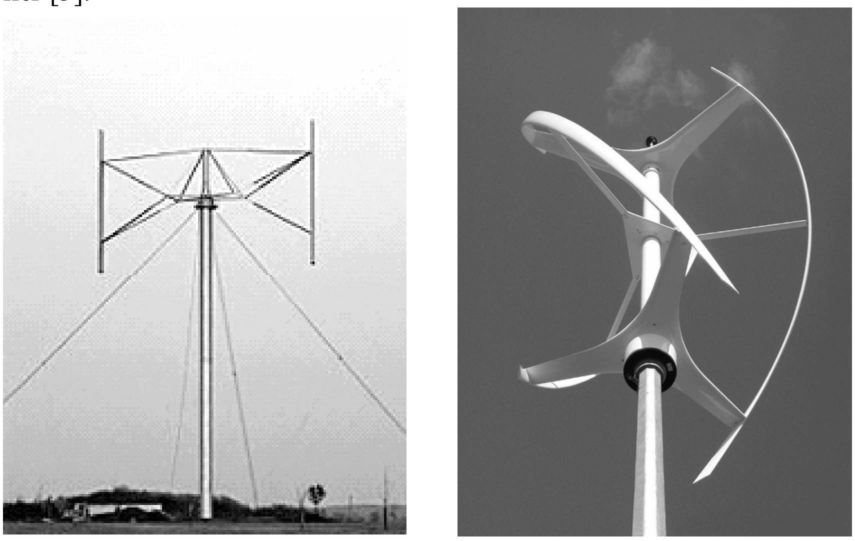

Fig. 10. The H-Darrieus wind turbine [13]

The general comparison of wind turbines was presented on Fig. 11. The horizontal axis defines the relation of the circumferential speed of the wind turbine, to the speed of wind V. The perpendicular axis defines the coefficient of use of the energy of the wind Cp, being the reference of the real mechanical power on the shafts of the given wind turbine in relation to the theoretical energy of the wind, operating on the same surface itself of the wind turbine of the horizontal axis.

One can conclude from the above mentioned figure, that developmental tendencies are, and will be, directed to the wind power stations of the horizontal axis in the three blade propeller version mainly - going towards the highest efficiency, with large reliability and technologically simple construction.

The incessant search for better solutions, being man's natural feature, leads to the formation of new conceptions of wind power stations. The example of one unclassified construction, with respect to the axis of the wind power station, is firm Magenn's conception presented on Fig. 12. Its working is based on using the pressure of the wind, like in the Savinouswind turbine. The turning of the roller, crosswise to the wind causes formation of buoyancy known as Magnus effect. Wind power station rises in the air thanks to this strength stretching the lines which are the point of the support for installed after sides generators simultaneously [8].

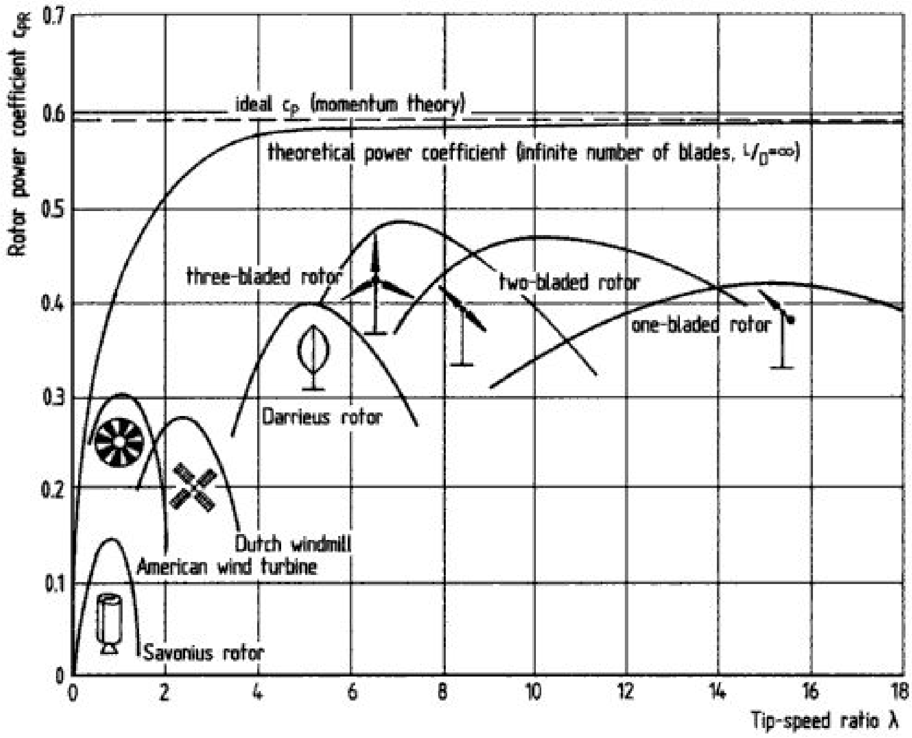

Fig. 11. The comparison of wind turbines [3]

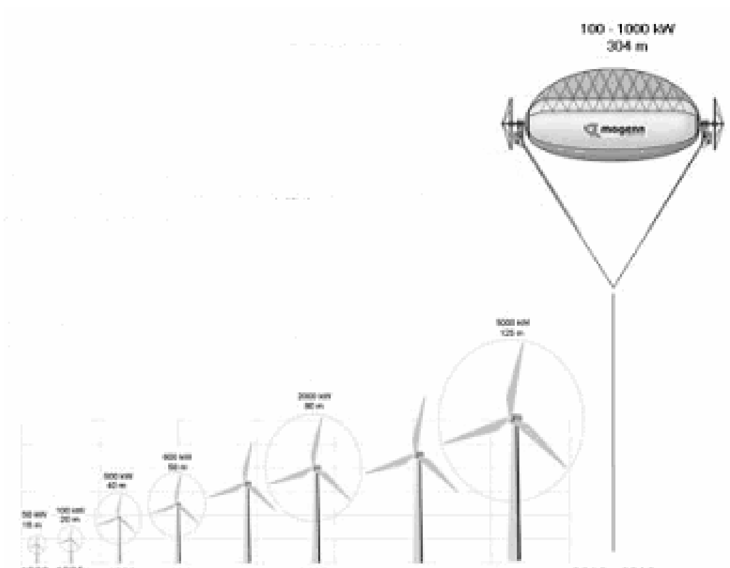

Fig. 12. The wind power station of the firm Magenn [8]

3. Summary

Weather and field conditions in Poland (Fig. 14) allow the installation even up to 23000 MW [1] power from a wind power station. At present, there are installed circa 1005 MW [1] wind power stations and next investments are planned in order to achieve the minimum imposed on Poland by UE. The prognosis of the development of the Polish energetics OZE on the basis of "Politics of Energy for Poland till 2030" [1] was presented on Fig. 13.

The difficulties with the quick development of wind energetics in Poland are connected first of all with the novelty of the subject having just several years. Investors willing to build the wind farm are exposed to heavy temporary financial tests. It takes not only the gathering of the huge quantity of working plan which can last up to two years, but also the annexation to often distant grid (Fig. 14) after building the wind farm.

The lack of concrete information about the windiness of a given area is the next factor discouraging potential investors. In order to plan the investment well, they have to put the special measuring station themselves working for at least a year. Despite huge advantages arising from the installation of the cleanest energy power stations, the ecologists look for negative sides, often using accidental situations e.g. the perishing the birds or damage of the scenery. The question arises, how the landscape will look like in next 2000 years if the production of the electricity and warmth will only be obtained through burning carbon and biomass.

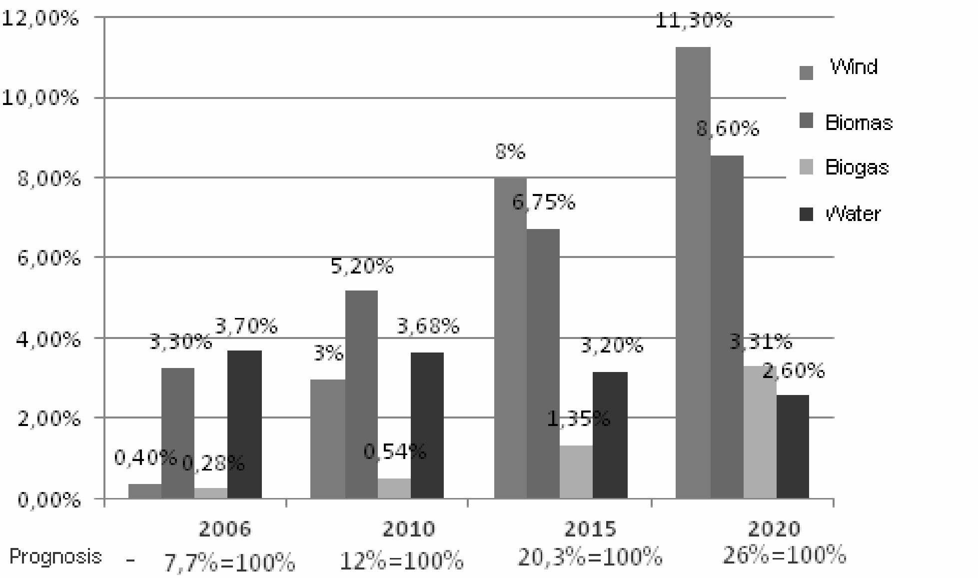

Fig. 13. The plans of the development of the economy of energetics in Poland till 2030 [1]

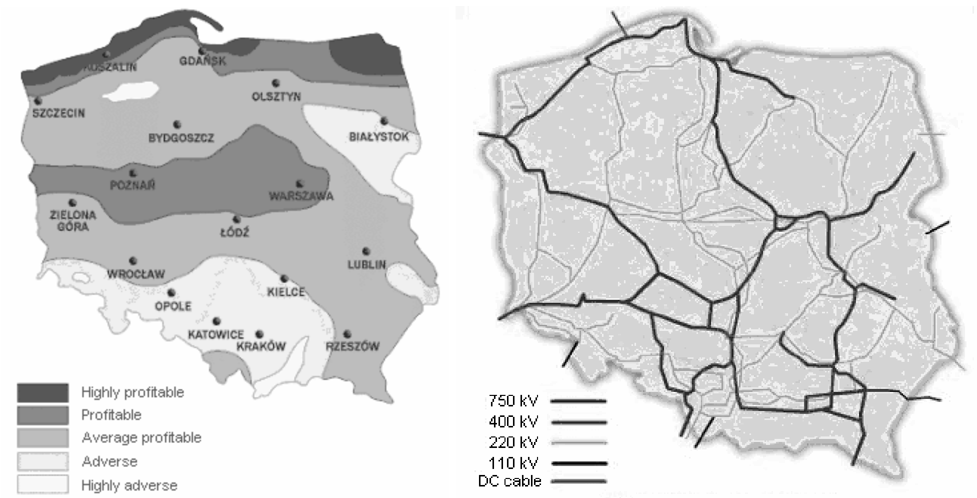

Fig. 14. The map of Poland - windy conditions, the arrangement of industrial nets enabling connecting wind power station [1]

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